REMR TECHNICAL NOTE CO-SE-1.3

HIGH-RESOLUTION SONAR SYSTEMS FOR BATHYMETRIC APPLICATIONS

PURPOSE: To update an assessment of commercially available sonar survey equipment suitable for performing high-resolution near-structure surveys.

INTRODUCTION: A review of contemporary high-resolution sonar systems has been performed to assess their applicability to near-structure surveys. The assessment procedure emphasizes the ability of the systems to provide information of a quantitative nature in addition to subsurface imagery. A crucial requirement for near-structure survey systems is specification or incorporation of datum which permits establishment of a reference plane which can be related to the elevation of the structure. A number of commercially available sonar survey systems provide quantitative information of various types. The desired information should be of a type that is readily related to the geometric form of the structure. Systems which provide, for example, depth data but are not accurately mapped in the horizontal plane are of limited use. Moreover, imagery which is not geometrically correct is, at best, useful only in the qualitative sense.

PROBLEM: A fundamental and persistent problem in attempting near-structure surveys aboard vessels is correcting for the vertical motion caused by wave action. An obvious tactic is to perform the survey when the wave action is at a minimum. However, the need for a survey is likely to be most urgent during periods when waves are present. In principle, it is possible to correct for the vertical motion of the vessel via several methods. Evaluations of vessel mounted gyro- and pendulum-stabilized accelerometers have been conducted with varying results. Vertical motion corrections have also been made by single integration of the Doppler shift of the sounding frequency (Ref. 1). Corrections may also be made possible by linking an onshore laser leveling system which continually monitors the elevation of the vessel to the data logger of the survey system. However, at present no such system is known to be available. Use of a small waterplane-area, twin-hull vessel (SWATH) also has been considered, but because of maneuverability requirements and shallow water near structures, SWATH vessels are not well suited to such surveys.

NEW DEVELOPMENTS: Recent advances in hydrographic surveying equipment have prompted a review of newly available systems and their potential applicability to near-structure surveys. Of particular interest are digital scanning systems which need not be vessel mounted and thus may not require vertical motion correction. Also available are digital profiling systems which are capable of producing a two-dimensional map in a single pass, thus minimizing the amount of motion correction necessary. One example of a digital scanning system is the Ulvertech dual scanning profiler manufactured in Great Britain. This system employs two very high-frequency (1 MHz) acoustic transducers, each capable of rotating through 180 degrees of arc. Both transducers are linked to a central surface control unit which combines the information from the transducers

into a single profile. While the very high-frequency transducers allow resolution of ± 1 cm, the maximum range is 40 m.

A somewhat similar system (Model 971) is marketed by Mesotech Systems Ltd., Canada. The Mesotech system uses a single transducer which scans horizontally at an oblique angle. The analog output from the transducer is digitized and color coded by a surface processor unit. The output from the surface processor can be recorded for postprocessing and concurrently viewed in any of several coordinate systems as a color-enhanced, two-dimensional or perspective image. A disadvantage of the Mesotech system is the requirement that the transducer be maintained in a vertical position to avoid image distortion. An accessory software processing package offered by Offshore Systems, Ltd. of Canada permits correction for tilt and swing provided the transducer head contains an inclinometer and compass. The software also allows creation of two- or three-dimensional mosaic contour drawings. The Offshore Systems package is available or adaptable for acoustic profiling systems offered by several manufacturers. Figures 1 and 2 are sketches showing typical operation of the Ulvertech and Mesotech systems.

Both the Mesotech and Ulvertech systems require between fifteen seconds and one minute to complete a single scan. Because maintaining a stationary position in a typical survey vessel for this length of time is difficult, it is not really feasible to operate these systems directly from a vessel. However, reasonable results should be obtained if the system is mounted on a ROV or fixed to a stationary mount.

In addition to the digital scanning systems, several variations of conventional side-scan sonars are commercially available. These systems, typically, are based upon previous side-scan systems to which image correction capability has been added. In general, the degree of accuracy to which the image can be corrected is a function of the accuracy to which the motion (translation, heave, pitch, roll, and yaw) of the surveying vessel is specified. If the vessel course and speed are kept constant, these systems are capable of providing relatively distortion-free images. Some of these systems include a separate channel for relative depth data, but as with some previously described systems, without a means of relating the depth data to a common reference, the data are of limited value.

A possible improvement to the high-frequency-high resolution/short-range compromise is an interferometric technique employed by the Bathyscan 300 system developed by Bathymetrics Ltd. of Great Britain. The Bathyscan system operates at 300 kHz, about the same frequency as conventional side-scan sonar systems; consequently, it is expected to have about the same range (Ref. 2). However, the Bathyscan 300 system, as presently configured, is intended to be vessel-mounted and thus would have to be adapted for stationary operation in order to avoid the same motion control problems affecting other side-scan sonar systems.

SUMMARY: The present level of technology of high-resolution bathymetry includes some commercially available systems which have definite potential for satisfying the requirements of adequate accuracy and resolution for near-structure surveys. However, an integrated system which acquires subsurface data fixed to a horizontal datum which can be structure related does not

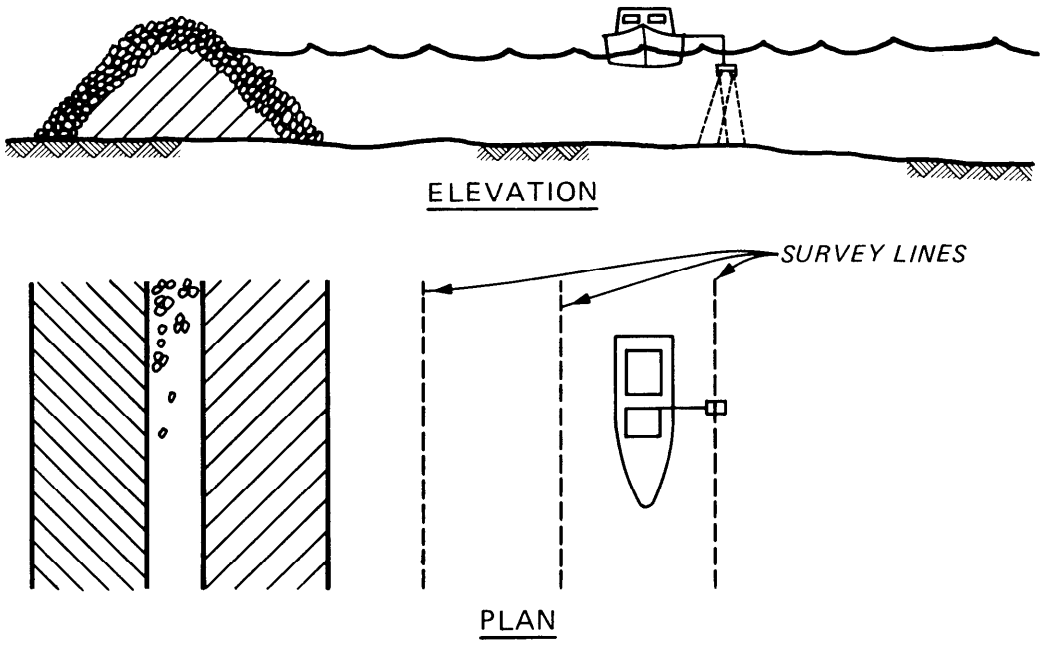

Figure 1. Sketch of typical operation of Ulvertech system

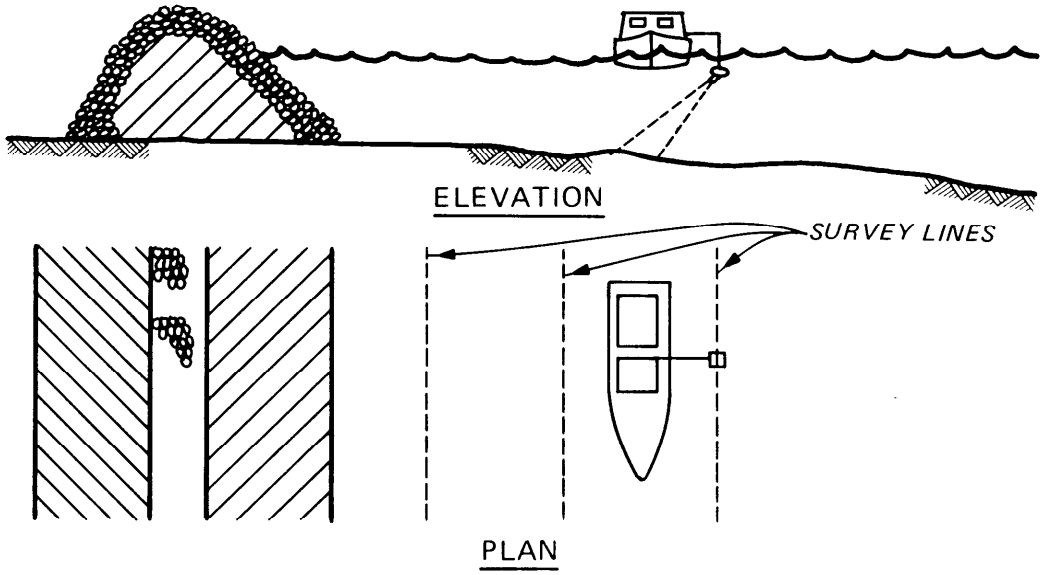

Figure 2. Sketch of typical operation of Mesotech system

appear to be commercially available at this time. It is possible that several of the assessed systems could be modified to provide the required data.

REFERENCES: 1. "Heave Compensation for Hydrographic Surveying," Coastal Engineering Technical Note CETN-VI-17, March, 1985, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, Vicksburg, MS.

2. Graham, David M. 1987. "Deep Seabed Mapping/Survey Systems," Sea Technology, Vol 28, No. 11, pp. 29-33.